Short-Term Physical and Mental Health Outcomes for Combat Amputee and Nonamputee Extremity Injury Patients

Ted Melcer
G. Jay Walker
V. Franklin Sechriest II
Michael Galarneau
Paula Konoske
Jay Pyo

Naval Health Research Center

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Naval Health Research Center
140 Sylvester Road
San Diego, California 92106

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Ted Melcer, PhD, G. Jay Walker, BA,† V. Franklin Sechriest II, MD,‡ Michael Galarneau, MS, NREMT,* Paula Konoske, PhD,* and Jay Pyo, DO§*

Objectives: The present study: (1) reports the early physical health complications, mental health outcomes, and outpatient health care utilization of patients with serious extremity injuries sustained during the Iraq or Afghanistan wars and (2) compares clinical outcomes between amputee and nonamputee extremity injury groups.

Method: This was a retrospective review of clinical records in military health databases for patients injured in the Iraq and Afghanistan wars. Health outcomes of amputee (n = 382, injured 2001–2005) and nonamputee patients (n = 274, injured 2001–2007) with serious extremity injuries (abbreviated injury score ≥ 3) were followed up to 24 months post injury. This study was performed at Naval Health Research Center, San Diego.

Results: Amputee and nonamputee groups had similar injury severity scores. Amputees had nearly double the risk of certain adverse complications (infections, anemia, septicemia, and thromboembolic disease), but other complications (osteomyelitis and nonhealing wound) were similar between the 2 groups. Amputees had significantly greater odds of certain mental health disorders including mood, sleep, pain, and postconcussion syndrome. However, amputees had significantly reduced odds of posttraumatic stress disorder compared with nonamputees. Amputees used various outpatient clinics significantly more than nonamputees.

Conclusions: Patients with serious combat extremity injuries showed high rates of adverse health outcomes in the short term. Amputees had higher rates of many but not all clinically important physical and mental health outcomes compared to nonamputees. These results are important for military orthopaedic surgeons and allied providers who care for and counsel these patients and clinicians and researchers who seek to understand and improve health outcomes in patients with extremity war injuries.

Key Words: blast injury, combat amputee, extremity injury, postinjury infections, mental health diagnoses, posttraumatic stress disorder

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INTRODUCTION

Patients with serious combat-related extremity trauma are recognized as having increased rates of numerous postinjury physical health complications and mental health disorders.[1–7] Few studies have compared health outcomes between amputees and nonamputees, although military physicians have reported some of the adverse health outcomes for patients with extremity trauma sustained during the Iraq and Afghanistan wars.[8–10] Such a comparison may be clinically relevant to distinguish the specific adverse health outcomes of amputees from other serious extremity injury patients. Amputees and nonamputee patients with serious extremity injuries also may differ in their health care needs during the early stages of their postinjury care.

There were 2 objectives for the present study. First, to identify and quantify relevant health outcomes that would provide information to improve the early multidisciplinary care of these soldiers. And the second was to determine how the health outcomes of amputees and nonamputees were similar or distinct by comparison.

We had 3 hypotheses for this study. First, relative to nonamputees with serious extremity injuries, amputees would have increased rates of numerous postinjury physical complications including infection, heterotopic ossification (HO), and thromboembolic disease including deep venous thrombosis and pulmonary embolism (DVT/PE).[9,11,12] Second, amputees would have increased rates of mental health issues, particularly cognitive changes such as nonorganic sleep, pain, and postconcussion syndromes.[6,9,13] A previous study at our institution found relatively low posttraumatic stress disorder

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From the *Medical Modeling, Simulation and Mission Support Department, Naval Health Research Center San Diego, San Diego, CA; †Science Applications International Corporation, McLean, VA; and ‡Department of Orthopedic Surgery; and §Comprehensive Complex Casualty Care Center, Naval Medical Center San Diego, San Diego, CA.

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Reprints: Ted Melcer, PhD, Medical Modeling, Simulation and Mission Support Department, Naval Health Research Center San Diego, 140 Sylvester Rd, San Diego, CA 92106 (e-mail: ted.melcer@med.navy.mil).

(PTSD) rates among recent amputees.[9] Third, these rates would decrease when compared with nonamputee patients. The hypothesized differences between injury groups (amputee versus nonamputee) should be independent of other potential confounding group differences, such as in overall injury severity or rates of traumatic brain injury (TBI).

MATERIALS AND METHODS

Patients

This study described the early postinjury physical health complications and mental health outcomes of patients who had serious extremity injuries as defined by an abbreviated injury score (AIS) ≥3. We retrospectively evaluated 656 US military personnel with combat injuries in the Afghanistan or Iraq wars between 2001 and 2007. These individuals had major limb amputations (excluding fingers and toes) or other serious extremity injuries without amputation. Patients with brain/spinal injuries causing extremity paralysis were excluded. This research was approved by an institutional review board.

Data Sources

Data came from Standard Inpatient Data Records, Standard Ambulatory Data Records, and Health Care Service Record files via TRICARE Management Activity at levels 4 and 5 medical facilities. Levels of combat care have been reviewed previously.[14] Level 1 is the earliest care provided by first responders on the front line. Level 2 provides surgical resuscitation by mobile forward surgical teams. Level 3 includes larger facilities in the combat zone with more advanced trauma care capabilities. Level 4 facilities are the first level of care outside the combat zone where definitive surgical treatment is performed, such as Landstuhl Regional Medical Center in Germany. Level 5 facilities are military treatment facilities in the United States. Health data included *International Classification of Diseases*, 9th Revision diagnostic codes, surgical procedure codes, and disposition codes. Records were merged from the Armed Forces Health Longitudinal Technology Application, which are routinely generated by credentialed providers for inpatient and outpatient encounters at military treatment facilities and government-reimbursed private clinics.

The nonamputee group was selected from the Expeditionary Medical Encounter Database (EMED)[14] (formerly known as the Navy-Marine Corps Combat Trauma Registry), which gathers data from Navy-Marine Corps levels 2 and 3 medical facilities, supplemented by data from level 4 and 5 facilities treating all military services. The EMED and the Joint Theater Trauma Registry[15] provided injury severity scores (ISS).

Research Design

The 2 injury groups consisted of a combat amputee group (n = 382, injured 2001–2005); data for this amputee group were identified by searching military health databases as described previously[9] and a nonamputee group (n = 274, injured 2001–2007) selected from the EMED using an algorithm to match nonamputee patients to individual amputee's injury and demographic profiles.

The nonamputee extremity injury group only included patients with serious extremity injuries as defined by AIS ≥3 (n = 274). An AIS score of ≥3 indicates a serious injury following well-established and standardized trauma scoring criteria.[5,14–16] The nonamputee group was selected from the EMED using an algorithm to match or near match nonamputee patients to individual amputee's injury and demographic profiles. Patients injured through 2007 were included to increase the selection pool to approximately 8000 individuals.

These were the 6 matching criteria: (1) ISS (square root ± 0.5), (2) AIS, (3) blast versus nonblast injury, (4) TBI status, (5) age, and (6) service. Criteria were weighted based on demonstrated relationships with health outcomes[14,15] (ISS = 20; primary AIS = 10; blast injury = 9; TBI = 6; secondary AIS = 2; service = 2; age = 1). Amputees were matched to polytrauma patients individually without replacement from highest to lowest amputee ISS. The polytrauma patient with the most points for matching to an amputee's characteristics was selected as the comparison subject. This algorithm matched amputees with polytrauma patients in 83% of cases.

Outcomes follow-up continued for 24 months post injury[17] or until patient medical records were no longer available in databases. Mechanisms of injury were blast (improvised explosive device, rocket-propelled grenade, grenade, mine, and mortar), gunshot wound, and others (eg, crush). As discussed, ISS and AIS were calculated based on standardized methods.[16] Complication and TBI codes for combat trauma cases were developed by a research trauma nurse and by an amputee care physician as described previously.[9] Diagnoses were grouped as adjustment, anxiety, mood, PTSD, substance abuse disorders, and other mental health diagnoses. PTSD was identified by an *International Classification of Diseases*, 9th Revision diagnostic code of 309.81 at least 30 days post injury. Preinjury mental health diagnoses were recorded beginning with the onset of each individual's military service, which includes standardized physical and mental health evaluation (Preinjury mental health disorders are frequently diagnosed during recruit training and before deployment.[17]) Health care clinic description codes indicated visits to specific outpatient clinics, including physical therapy, occupational therapy, psychiatric, and prosthetics and orthotics care.

Data Analysis

Percentages of patients with specific health outcomes (eg, infections, PTSD) were based on the total number of patients in each group and calculated across the entire follow-up period and for consecutive 3-month intervals or quarters postinjury. The χ^2 tests evaluated differences between amputee and nonamputee groups in demographic and outcome measures.

Logistic regressions determined predictor variables significantly and independently associated with outcomes. Variables consisted of injury group (amputee versus nonamputee extremity injury), ISS, injury year, age, preinjury mental health diagnosis, and TBI. Outcome variables were infections, HO, DVT/PE, any mental health diagnosis, adjustment, anxiety, PTSD, mood disorders or other mental health disorders, and psychiatric and physical therapy clinic use.

RESULTS

Table 1 shows demographic and injury characteristics. The findings demonstrated that both groups consisted of males (99%), and amputees were older than nonamputees. The amputee sample consisted of more army personnel than the nonamputee sample (nonamputee patients were selected from EMED, which primarily captures medical data at Navy-Marine Corps facilities). Both groups showed similar low rates of preinjury mental health diagnoses. Amputees had a significantly higher rate of blast injuries but similar overall ISS compared with nonamputees. The majority of serious extremity injuries (AIS $\geq$ 3) occurred in the lower limbs (versus upper limbs) in both groups. Nonamputees had significantly higher TBI rates than amputees.

Outcomes Follow-up

We calculated how long patients' military health data remained available for follow-up outcomes. First year follow-up rates were near 90% with no significant differences between groups through the first 9 months post injury (amputees = 95% versus nonamputee extremity = 96.0%). A small change appeared at 12 months post injury but by 18 and 24 months; follow-up rates were significantly lower for amputees than nonamputees (18 months: amputees = 55% versus nonamputee extremity = 72%, $P < 0.001$; 24 months: amputees = 33% versus nonamputee extremity = 58%, $P < 0.001$).

Table 2 shows that complication rates were higher for amputee than nonamputee patients. However, amputees showed significantly higher rates than nonamputees only for a subset of complications: any infection, anemia, HO, septicemia, deep vessel thrombosis, and/or pulmonary embolism ($P < 0.05$).

TABLE 1. Descriptive Statistics by Combat Injury Groups From the Iraq and Afghanistan Wars

Demographics	Percentage or Mean: Combat Amputee (n = 382)	Percentage or Mean: Nonamputee Extremity Injury (AIS ≥ 3) (n = 274)	*P*
Age (mean years)	26.0 (18–48)	24.1 (18–49)	0.01
Sex (% male)	98	99	NS
Service (%)			0.01
Army	70	25	
Marine Corps	25	72	
Other	5	3	
Previous MH diagnosis (%)	6	8	NS
Mechanism of injury (%)			0.01
Blast	86	65	
Gunshot	2	33	
Others	12	12	
ISS (mean)	15.6	15.3	NS
Lower extremity injuries (%)*	73	69	NS
TBI (%)	22	31	0.01

*Percentage of patients in each group who had a serious (AIS $\geq$ 3) lower extremity injury. The remaining patients in each group had a serious (AIS $\geq$ 3) upper extremity injury.

MH, mental health; NS, not significant.

TABLE 2. Complication Rates for Combat Amputee (n = 382) and Nonamputee Extremity Injury Patients (n = 274)

Complication	Combat Amputee: n	Combat Amputee: %	Nonamputee Extremity (AIS ≥ 3): n	Nonamputee Extremity (AIS ≥ 3): %
Any infection*	219	57.3	117	42.7
PLS	212	55.5	—	—
Anemia*	169	44.2	73	26.6
Postoperative infection	102	26.7	59	21.5
Osteomyelitis	84	22.0	54	19.7
Cellulitis†	69	18.1	35	12.8
HO*	69	18.1	28	10.2
Amputation stump complications	66	17.3	—	—
Chronic infection, amputation stump	56	14.7	—	—
Pneumonia	47	12.3	29	10.6
Nonhealing wound	42	11.0	30	10.9
Septicemia*	42	11.0	16	5.8
DVT±	36	9.4	16	5.8
Pulmonary embolism±	27	7.1	11	4.0

*Percentages for amputee group > extremity group ($P < 0.05$).

†$P < 0.08$.

PLS, phantom limb syndrome; ±, deep vessel thrombosis and/or pulmonary embolism ($P < 0.05$).

Table 3 shows that amputees had a significantly higher rate of mental health diagnoses than the nonamputee group ($P < 0.01$). Amputees had substantially and significantly higher rates of "other" diagnoses (eg, pain, sleep, postconcussion syndrome) than nonamputee extremity patients. By contrast, PTSD rates among amputees were significantly reduced compared to nonamputees ($P < 0.01$). However, these groups did not differ significantly in rates of any of the remaining major disorder categories (anxiety, adjustment, mood, and substance abuse).

Table 4 shows that amputees received significantly more care at outpatient clinics than nonamputee patients, with the exception of the orthopaedic clinic. We note that amputees received day-to-day pain management from their physical medicine and rehabilitation physicians rather than the pain management outpatient clinic.

Exploratory χ^2 tests indicated group differences (amputee versus nonamputee extremity injury) in age, TBI, mechanism of injury, and injury year, and these variables were significantly associated with health outcomes. Covariates for regression modeling were ISS, TBI, age (<25 versus >25), injury year (2001–2005 versus 2006–2007), mechanism of injury (blast, gunshot wound, or others), and preinjury mental health diagnosis.

Amputees showed increased odds of any infection, DVT/PE, and HO relative to nonamputee patients (Table 5). Injury group was not significantly associated with rates of osteomyelitis.

The logistic regression model showed substantially increased odds ratios for amputees compared with nonamputees for a number of mental health measures including any mental health diagnoses, a category of other mental

TABLE 3. Mental Health Diagnoses for Combat Amputee and Nonamputee Extremity Injury Patients

	Combat Amputees (n = 382)		Nonamputee Extremity Injury (AIS ≥ 3) (n = 274)		
Disorder Category	**n**	**%**	**n**	**%**	***P***
Any mental health diagnosis	252	65.9	145	52.9	0.01
Adjustment disorder	93	24.3	56	20.4	NS
Anxiety disorder	97	25.4	63	23.0	NS
Mood disorder	78	20.4	39	14.2	0.09
Posttraumatic stress disorder	69	18.1	88	32.1	0.001
Substance abuse disorder	23	6.0	23	8.4	NS
Other mental health disorders	167	43.7	30	10.9	0.01

Each patient may have been diagnosed with 1 or more disorders. Other mental health disorders included cognitive disorder not otherwise specified, postconcussion syndrome, nonorganic sleep disorders, and psychogenic pain.
NS, not significant.

health diagnosis (eg, pain, sleep, postconcussion syndrome), and the utilization of psychiatric clinics (Table 5). Mood disorders also showed significance. In contrast, amputees had reduced odds of PTSD by approximately 50% compared with nonamputee extremity patients.

Amputees had numerically higher rates of new or first time postinjury diagnoses of adjustment, anxiety, mood, and other disorders during the first quarter postinjury compared with nonamputee extremity injury patients (Figure). The largest increase for amputees was for other disorders, which persisted throughout the first 5 quarters. New-onset PTSD cases occurred at numerically higher rates for nonamputees than amputee patients during most quarters of the first 2 years post injury. Rates for each quarter were adjusted for the number of patients remaining in the military health care system. A similar pattern of group differences in mental health outcomes was described for entire the 2-year follow-up period (Table 3).

DISCUSSION

Health consequences for patients with combat-related extremity trauma are among the leading challenges for military health care providers. This study investigated short-term adverse health outcomes for combat extremity trauma patients and compared these outcomes between amputees and nonamputees. This study provides one of the first objective reports of short-term adverse physical and mental health outcomes for amputee and nonamputee patients after serious combat extremity trauma sustained in Iraq and Afghanistan.

Consistent with our hypothesis, amputees had increased rates of most postinjury physical health complications relative to nonamputees (Tables 2 and 5). From this finding, we emphasize several conclusions. Foremost, both amputee and nonamputee patient groups showed high rates of infection (Table 2, 57% for amputees) relative to previous reports.[3,4] Prevention of orthopaedic infections is well recognized as a major challenge and has been given high priority in the planning and execution of medical care provided to combat casualties in Iraq and Afghanistan.[3,4] Our findings strongly support current recommendations to prioritize research and development of more aggressive infection control and wound management practices for all combat extremity patients, particularly amputees.[4] Second, both amputee and nonamputee patient groups were documented to have high rates of thromboembolic disease. Because thromboembolic complications may delay rehabilitation, increase hospital length of stay, and, in some cases, cause death in trauma patients, our finding indicates the need for earlier and potentially more aggressive DVT/PE surveillance and/or prophylaxis for all combat extremity patients, especially combat amputees.[12] Finally, contrary to our expectations, amputee and nonamputee groups had no significant differences in rates of postoperative wound infection, nonhealing wounds, and osteomyelitis (Table 2). This novel finding further illustrates the challenge of infection control when managing any patient with high-energy and/or highly contaminated combat extremity trauma and

TABLE 4. Outpatient Clinic Use and Number of Visits by Injury Group

	Combat Amputees		Nonamputee Extremity Injury (AIS ≥ 3)	
Clinic Type	**Use Rate (%)**	**No. Visits (Median)***	**Use Rate (%)**	**No. Visits (Median)***
Physical therapy clinic	91	90	90	21
Occupational therapy clinic	89	29	67	10
Prosthetic/orthotic laboratory	85	24	18	2
Psychiatric clinic	83	27	27	8
Orthopaedic clinic	73	2	87	6

$P < 0.05$ for all differences between amputee and nonamputee groups' use rates (except physical therapy).
*Number of visits is for patients who used clinics.

TABLE 5. Results of Logistic Regression Analyses

Postinjury Outcomes Variables				
	OR (95% CI)			
Independent Variables	Any MH Diagnosis	Mood Diagnoses	PTSD	Other MH Diagnoses
Injury group (amputee versus nonamputee extremity AIS ≥ 3)	2.12 (1.51–2.96)	1.55* (1.02–2.35)	0.48 (0.34–0.69)	7.36 (4.69–11.55)
ISS (log)	1.78 (1.28–2.47)	—	—	2.15 (1.49–3.10)
Age (<25 versus >25), y	0.66* (0.47–0.93)	—	—	—
TBI	—	—	—	1.73* (1.12–2.69)

Postinjury Outcomes Variables				
	OR (95% CI)			
Independent Variables	Any Infection	DVT/PE	HO	Psychiatric Clinic Use
Injury group (amputee versus nonamputee extremity AIS ≥ 3)	1.83 (1.33–2.50)	1.77* (1.04–3.02)	1.96 (1.21–3.16)	19.88 (13.24–29.87)
ISS (log)	1.52 (1.13–2.05)	3.23 (1.98–5.26)	3.20 (2.07–4.96)	1.74 (1.19–2.52)
Age (<25 versus >25), y	—	—	—	—
TBI	—	—	—	—

Significance levels for odds ratios were $P < 0.01$ unless annotated. Injury group showed no significant association with preinjury MH disorder, postinjury anxiety, or adjustment disorders in the final regression models. Mechanism of injury was not a significant factor in the final models for any MH diagnosis or PTSD.

*$P < 0.05$.

CI, confidence interval; MH, mental health; OR, odds ratio.

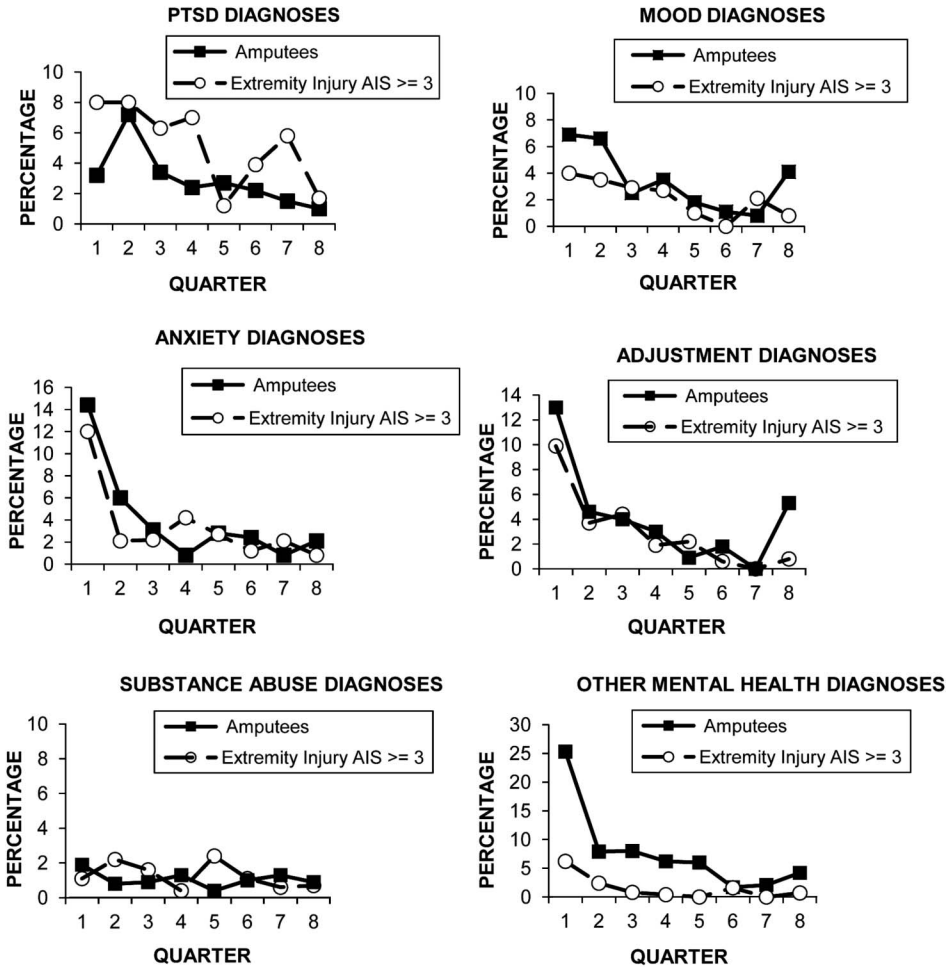

FIGURE 1. Quarterly rates of new-onset mental health diagnoses for combat amputee and polytrauma patients.

emphasizes the need for further scientific and clinical study to elucidate why amputees and nonamputees share similar odds for certain acute and chronic wound infections.

Amputees had increased rates of any mental health diagnosis relative to nonamputees, including nonorganic sleep and pain disorders and postconcussion syndrome (Tables 3 and 5). Onset of these disorders occurred primarily during the first year post injury (Figure). This finding reinforces the importance of early and/or aggressive therapies to mitigate the effects of these disorders. Amputees and nonamputees had similar rates of adjustment, anxiety, and substance abuse disorders. The present results also demonstrated that combat amputees had decreased PTSD rates compared with nonamputees. A full analysis of the likely multiple factors responsible for this effect was beyond the scope of the present study. We are currently investigating postinjury care factors of amputees (eg, battlefield pain medications and/or subsequent rehabilitation therapies) that may be protective against early PTSD development.[18–20]

In the weeks and months after injury, amputees used outpatient clinical services more than nonamputees. This finding is consistent with the goals of the Amputee Care Program[2] to provide amputees with timely and structured access to rehabilitation, pain management, psychiatric care, peer support, and rapid transition to activity through advanced prostheses and physical therapies. The present findings suggest early medications, and physical and/or psychological rehabilitation therapies may reduce the likelihood of certain mental health disorders, at least by comparison with other serious extremity injury patients.[9,18,19]

The strengths of this study include a relatively large sample of combat amputees (n = 382) and nonamputee extremity injury patients (n = 274) injured in Iraq or Afghanistan. Injury and health outcomes data sources were based on objective clinical medical records including in-theater medical facilities.[14] These databases facilitated longitudinal tracking of a wide range of health outcomes for relatively large samples of combat extremity injury patients.

A limitation of this study was the abbreviated follow-up period due most commonly to a patient's discharge from military service. Although 90% of both groups had data available for the first year post injury, there was 50% attrition by 18 months. However, the major conclusions for physical/mental health outcomes were based on data from the first year post injury when subject attrition was relatively low for both groups. The absolute rates of some complications (DVT/PE and HO) were lower than previous reports.[11,12] However, the present conclusions were based on amputee versus nonamputee group comparisons and were consistent with previous research.[9,11] Absolute rates of other complications (phantom limb syndrome, osteomyelitis, and infections) were consistent with previous studies.[4,10,21]

We are currently collaborating with Naval Medical Center San Diego's Department of Orthopaedic Surgery on specific identification of patients with leg-threatening injuries for comparison to combat amputees.[17] The EMED[14] now provides accessible data from far forward battlefield care facilities including descriptions of combat extremity injuries (eg, complex fractures) necessary to identify leg-threatening injuries.[18]

CONCLUSIONS

Amputees had increased rates of most adverse physical outcomes (infections, anemia, and DVT/PE) but similar rates of certain postinjury complications such as osteomyelitis and nonhealing wounds. Amputees also had substantially increased rates of mental health disorders related to pain, sleep, and postconcussion syndrome. However, the odds of PTSD were reduced by approximately 50% relative to nonamputees. Amputees used outpatient clinical services significantly more than nonamputees.

Thorough knowledge of the type and frequency of adverse health outcomes is important for military orthopaedic surgeons and the allied providers who manage patients with extremity war injuries. The present results provide insight to clinicians and those who seek to understand and improve health outcomes through research. Finally, to our knowledge, this is the first study to suggest how early physical and mental health outcomes of amputees may be unique by comparison to a carefully selected group of patients with serious extremity injuries not resulting in loss of limb.

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Commanding Officer
Naval Health Research Center
140 Sylvester Rd
San Diego, CA 92106-3521

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Commanding Officer
Naval Medical Research Center
503 Robert Grant Ave
Silver Spring, MD 20910-7500

Commander
Navy Medicine Support Command
P.O. Box 140
Jacksonville, FL 32212-0140

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14. ABSTRACT

Introduction: Recent combat amputees injured in the Afghanistan and Iraq wars have unique injuries and challenges during rehabilitation. This study evaluated amputee outcomes with those of nonamputee polytrauma and minor injury patients.
Method: Combat amputees and nonamputee polytrauma and minor battle injury groups were identified retrospectively in military health databases and followed for 2 years postinjury. Polytrauma patients were selected to match amputee injury and demographic profiles. Outcomes data were diagnostic/procedure codes recorded longitudinally in the databases.
Results: Amputees had increased risk of numerous complications (e.g., infections, heterotopic ossification) and certain types of mental health disorders, and increased use of outpatient clinics compared with polytrauma patients. The odds of any mental health diagnosis and adjustment disorder doubled among amputees versus polytrauma patients. However, amputees had reduced odds of posttraumatic stress disorder by approximately one half compared with polytrauma patients, and these groups did not differ significantly in odds of mood or anxiety disorders. Both amputee and polytrauma groups showed increased rates of all mental health disorders versus minor injury patients.
Conclusions: Recent combat amputees have substantially increased risk for numerous complications and certain psychological disorders versus nonamputee polytrauma patients. Postinjury care factors may facilitate initial psychological recovery and rehabilitation of recent combat amputees.

15. SUBJECT TERMS
combat amputee and polytrauma patients, complications, PTSD, mental health diagnoses, health care use

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